


Challenges Testing Low Impedance Bus Differential Relays

Terrence Smith– GE Grid Solutions

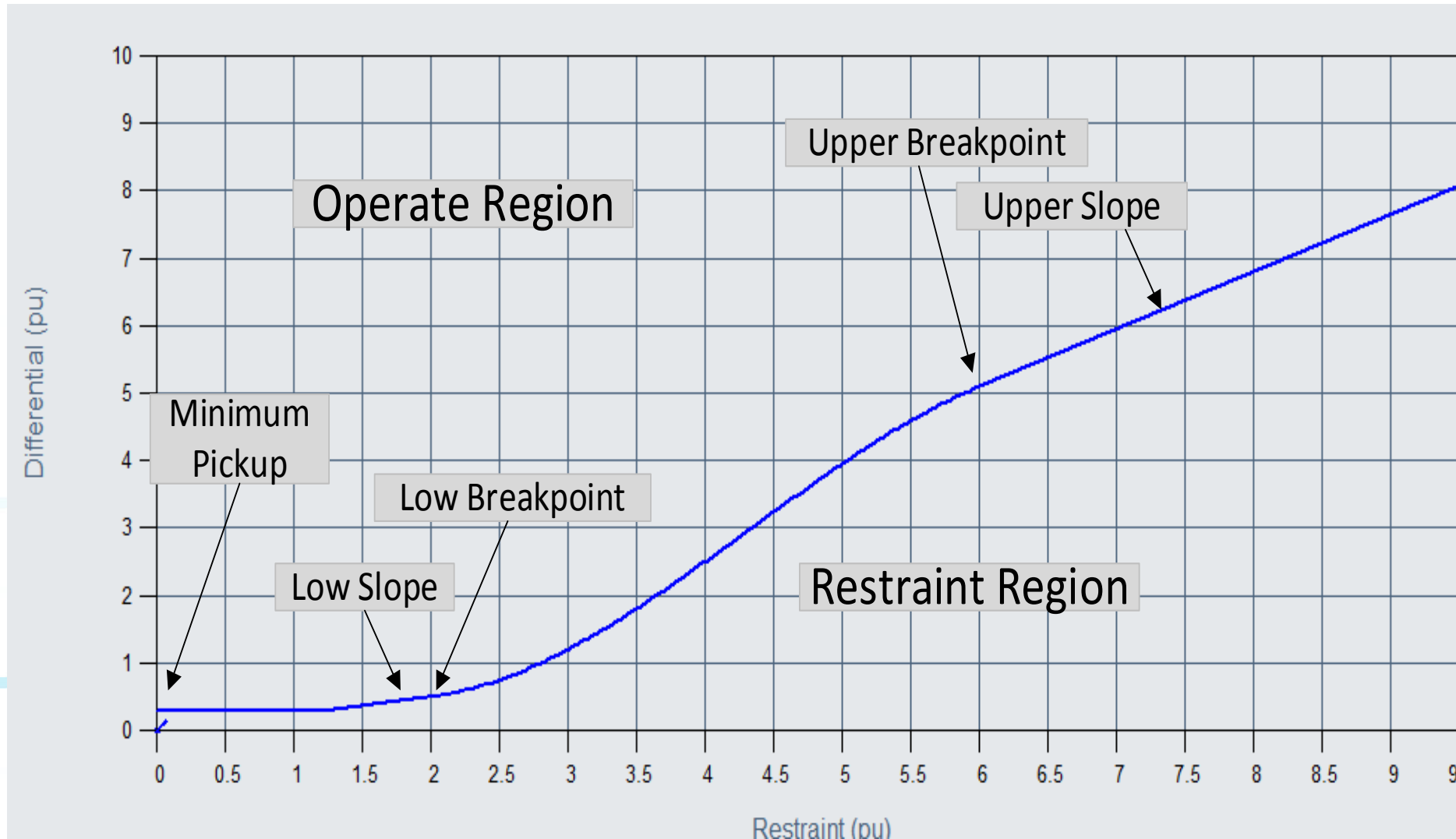
Paul Smith– GE Grid Solutions

Jason Eames– Tennessee Valley Authority

Agenda

- Introduction
 - The big Bus Challenge
 - Testing sloped Differential Characteristics
 - Testing Pickup of Sloped Differential Characteristics.
 - Dealing with CT mismatch
 - Dealing with Algorithm security
- 

Sloped Differential Characteristic

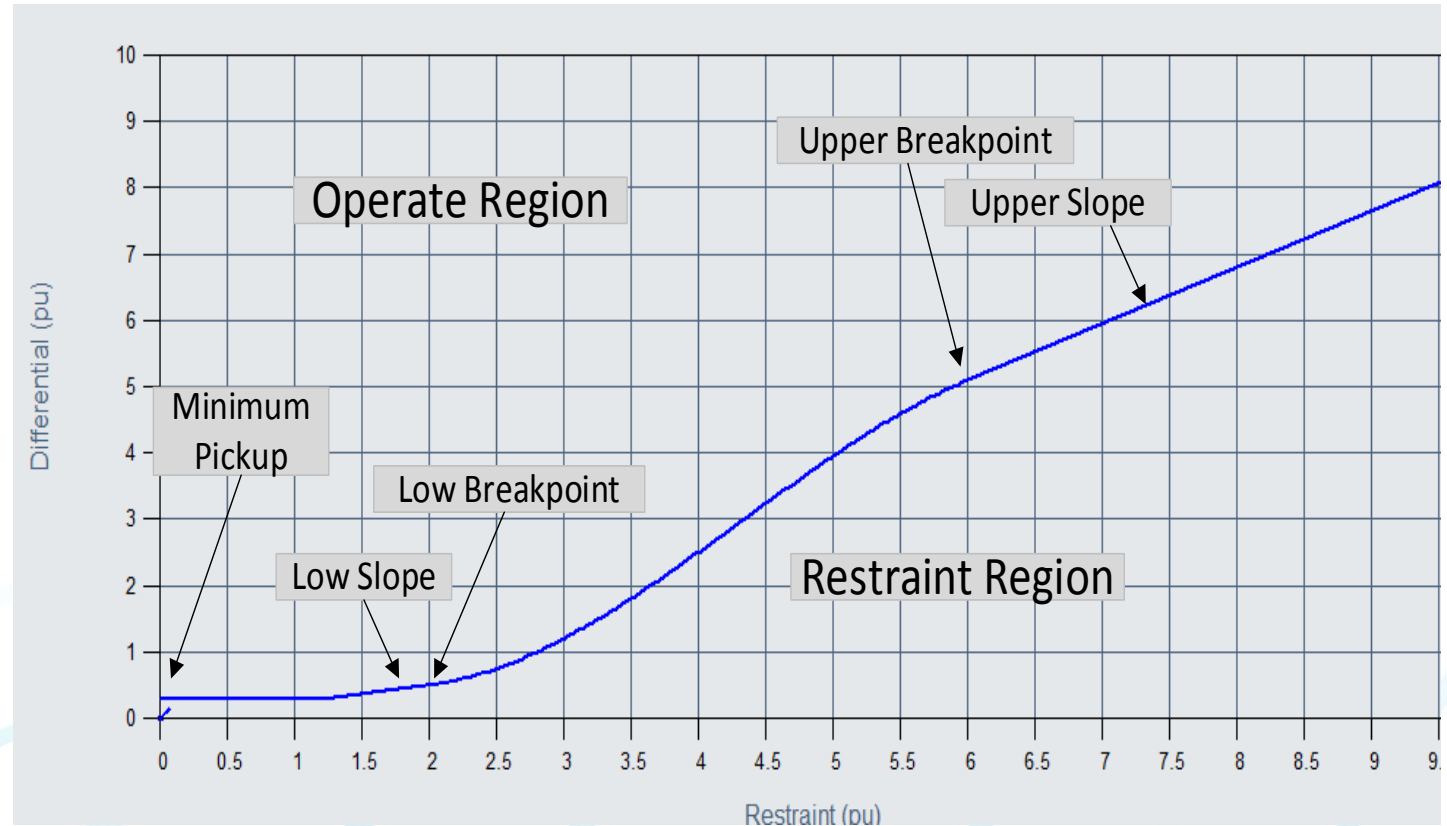


Testing Sloped Differential Characteristic

$$\frac{I_1 + I_2}{I_R} > \text{Slope}$$

$$I_1 > I_2(\text{Slope} - 1)$$

If both currents are 5 amps and slope is 25%, operation occurs when one current is at 5 amps and second current is at 4 amps



Sloped Differential Characteristics Pickup

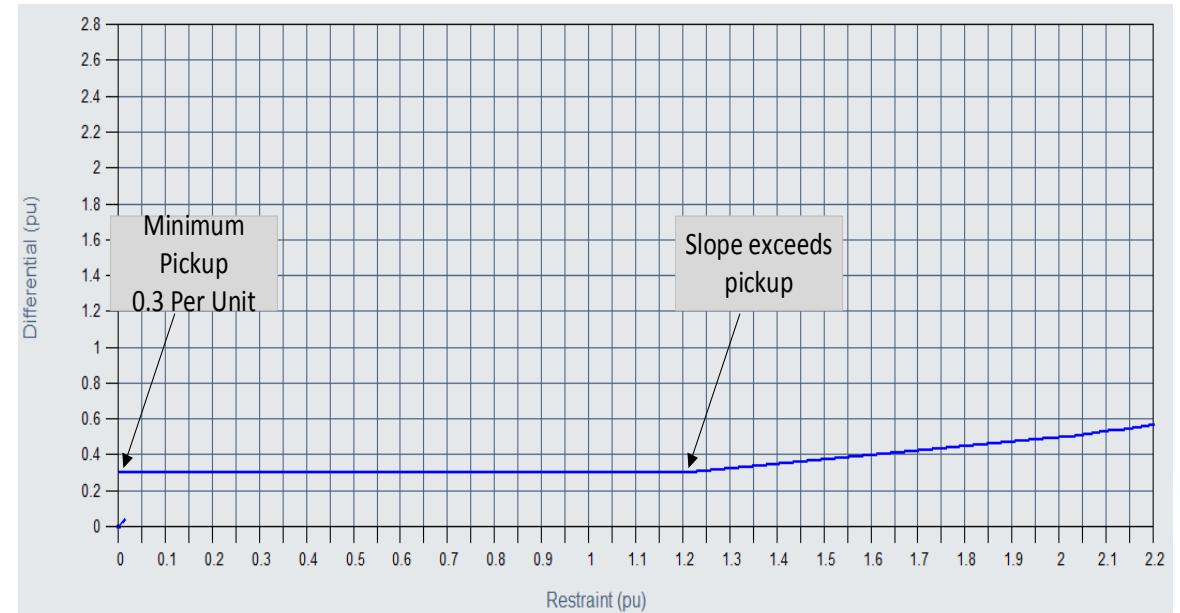
$$I_D > PU$$

$$I_D = I_1 + I_2$$

$$PU = I_1 + I_2$$

$$I_1 = PU - I_2$$

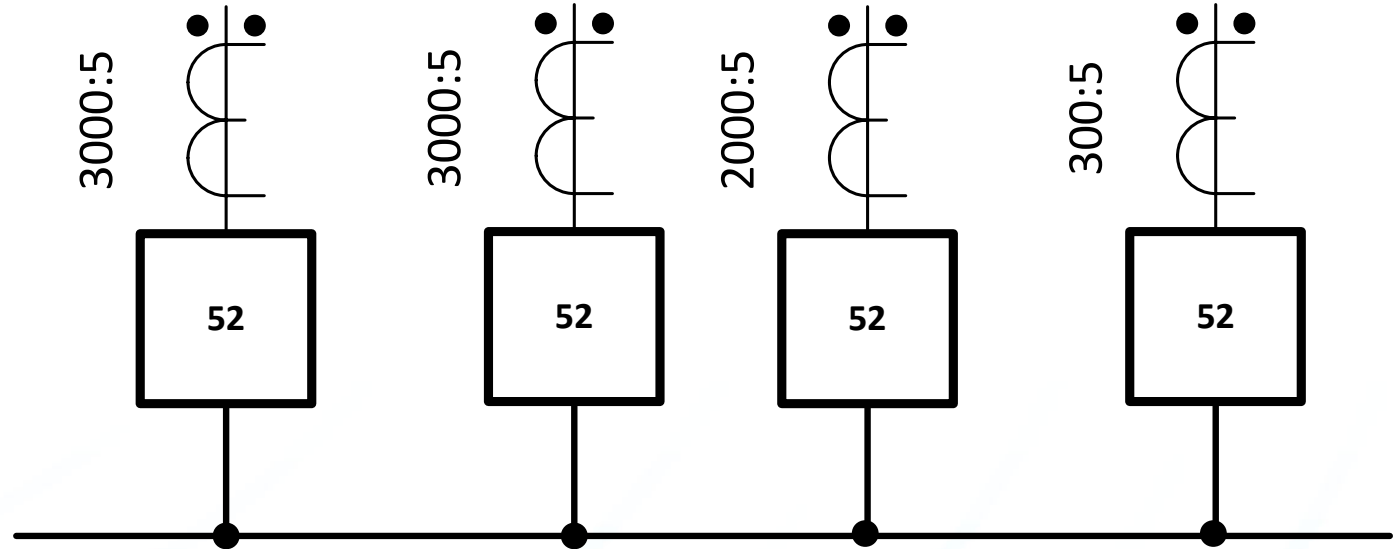
If slope=25% and pickup is 0.3xCT,
normal operation occurs at 6A and
4.5A....



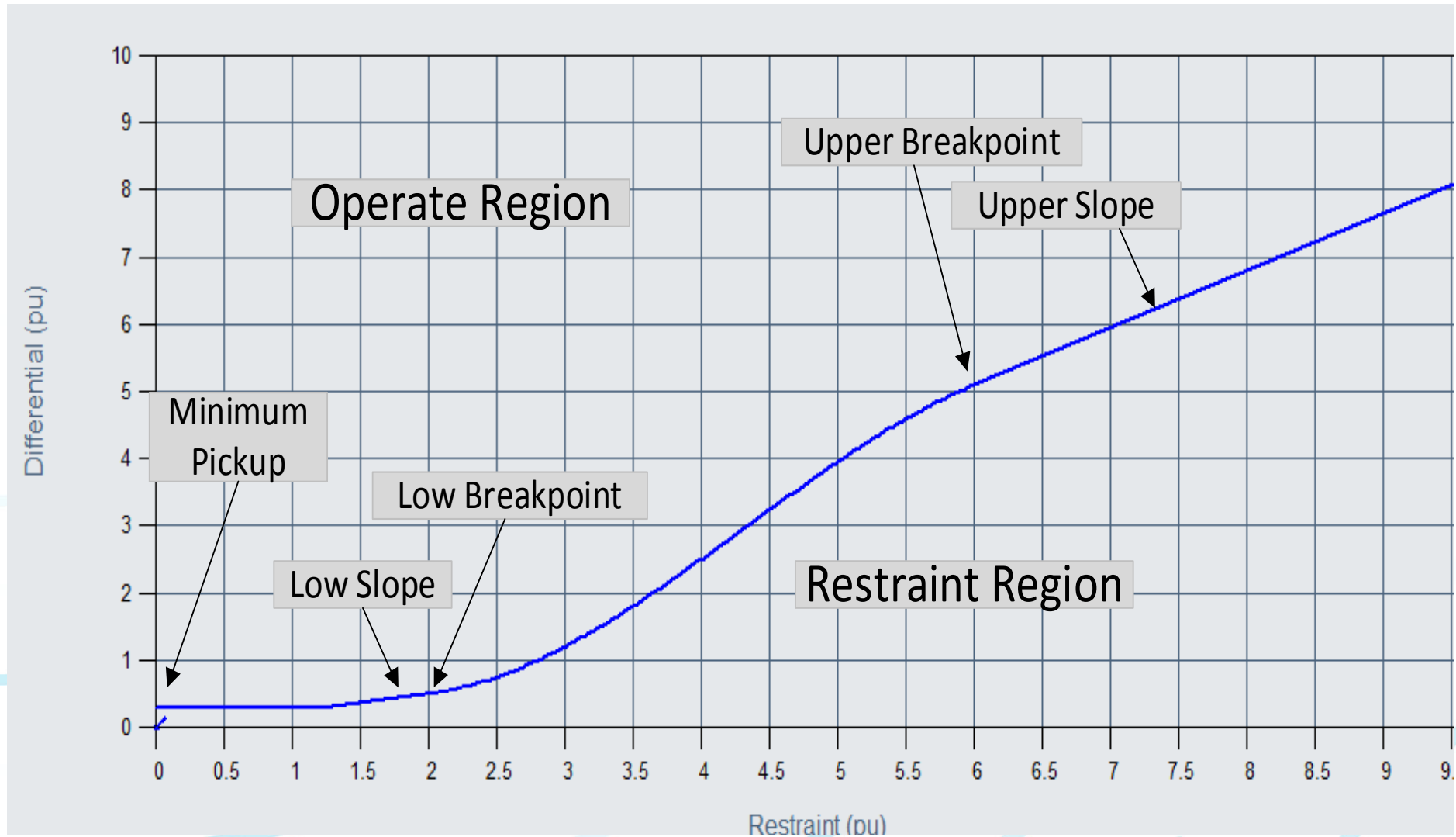
Mismatched CTs

$$I_1 = PU - I_2 \frac{CTRatioI_2}{CTRatioI_1}$$

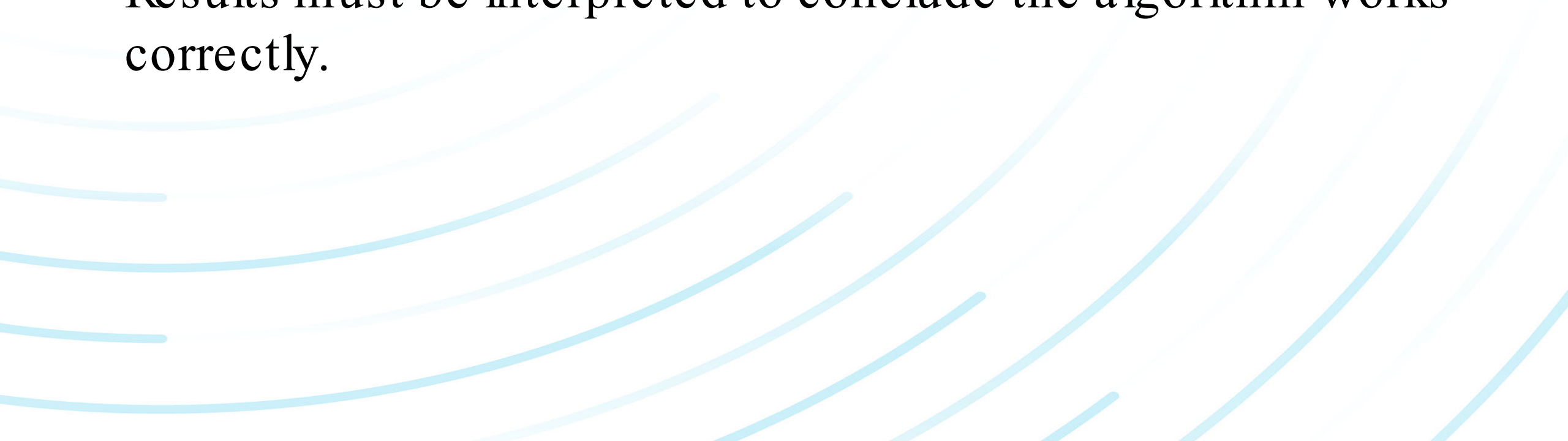
$$I_1 = I_2 (Slope - 1) \frac{CTRatioI_2}{CTRatioI_1}$$



Security Algorithms



Conclusions

- Remember the goal of testing – that element works as described and that the algorithms are appropriate.
 - Automation Helps but it often takes a human to interpret the results.
 - Results must be interpreted to conclude the algorithm works correctly.
- 

Thank You

Questions?

